HEAT TRANSFER DURING TURBULENT FLOW IN VERTICAL AND HORIZONTAL TUBES CONTAINING WATER WITH SUPERCRITICAL STATE PARAMETERS

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The results are reported of an experimental study of heat transfer in ascending, descending, and horizontal flows in tubes containing water with supercritical parameters of state, when all the thermophysical properties of the flow are subject to rapid variations.

The measurements were carried out for the following ranges of the parameters: pressure – 225-265 bar, mass velocity – 480-5000 kg/m^2·sec, Reynolds number – $12.5 \cdot 10^3$-$450 \cdot 10^3$, specific thermal load – 0.2-6.5 MW/m^2, temperature of the flow – 50-500°C, wall temperature – 60-750°C, internal tube diameter – 0.003, 0.008, and 0.020 m, relative tube lengths – l/d up to 300, relative thermal load – $q \cdot 10^{-3}/\rho w$ up to 1.45 W·sec/m.

In the case of ascending motion of the coolant at low flow rates (480-500 kg/m^2·sec) and relative thermal loads in excess of 0.8 W·sec/m, the experimental situation corresponded to rapid local deterioration in heat transfer. For enthalpy values preceding the pseudophase-transition zone, these experiments showed the appearance of wall temperature peaks which occasionally exceeded 700°C.

In 20 mm diameter tubes with preliminary hydrodynamic stabilization it was found for the same range of rates of flow and thermal loads with l/d = 10-60 that there were temperature peaks even at very low (200 kJ/kg) values of enthalpy.

In the case of descending motion of the coolant, there was practically no local deterioration in heat transfer or any effect of the direction of motion for rates of flow in excess of 1000 kg/m^2·sec. In experiments performed with horizontal tubes there was a substantial difference between the temperatures of the upper and lower generators which, in many cases, reached up to 150°C.

Strong hydrodynamic instability was observed in individual cases in the course of the experiments. A special series of experiments was performed to establish the conditions under which the instability set in and how it could be suppressed.

Experimental data on ascending motion were compared with the results reported in [1, 2] under similar conditions. The data are in good agreement with the work reported in [1].

LITERATURE CITED

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